Distr.
LIMITED

IPCT.13
22 January 1987

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

ENGLISH
ORIGINAL: FRENCH

Second Consultation on the
Training of Industrial Manpower

Paris, France, 14-18 September 1987

TRAINING FOR INDUSTRIAL MAINTENANCE WORK IN THE DEVELOPING COUNTRIES*

Prepared by

Jacques Perrin**

---

* This document is an unofficial translation reproduced without formal editing.

** Researcher CNRS, IREP-D Université des Sciences Sociales de Grenoble.

V.86 62732

CONTENTS

	Pages
1) THE LACK OF MAINTENANCE KNOW-HOW IN THE L.D.C.s : A PROBLEM CALLING FOR A RAPID SOLUTION	2
1.1. Many breakdowns... however the lack of maintenance know-how only explains some of the interruptions in production	2
1.2. The costs of the lack of maintenance know-how	3
2) MULTIDIMENSIONAL MAINTENANCE	4
2.1. Procedures used when engaging on maintenance work	4
2.2. Objectives of maintenance work	4
2.3. Maintenance levels	5
2.4. The functions which constitute maintenance work	6
2.5. Conclusion : maintenance is mainly to do with information	7
3) PARTICULARITIES OF INDUSTRIAL MAINTENANCE PROBLEMS IN THE L.D.C.s	8
3.1. The poor functioning of supply networks for spare parts	8
3.2. Insufficient capacities of local maintenance services	9
3.3. The lack of industrial traditions in the labour force	10
3.4. Turnkey factories	10
3.5. Capital equipment from different countries	11
3.6. Conclusion : In a non-industrial environment there is a greater need for collecting and processing information	11
4) MAINTENANCE TRAINING REQUIREMENTS IN THE L.D.C.s	12
4.1. Action to be undertaken with regard to three different categories or operators	12
4.2. Two action priorities : organization and standardization	13
4.3. Different needs from one country to another	13
5) PROPOSALS FOR ACTION BY UNIDO IN THE FIELD OF MAINTENANCE TRAINING	15
5.1. Drafting of the "maintenance" part of standard specifications concerning purchases of capital equipment	15
5.2.Assistance in codifying spare-parts	16
5.3. Information processing as an aid to maintenance management	16
5.4. New methods in maintenance training to be encouraged	17

Since the early eighties many developing countries have become concerned with trying to make the production units which they have bought function properly. In this respect a thorough knowledge of repair operations and more particularly of maintenance has become a must.

In his opening speech to the national seminar on maintenance in Algiers, June 1983, the Algerian Minister of Heavy Industry recognized that "Over the last ten years, one of our main priorities has been to set up a basic industrial infrastructure. A rapid and substantial investment drive, which was intended to stimulate economic growth and help the country out of under-development, has not always been accompanied by a preoccupation with maintenance to match the industrialization effort. As the operation process began to develop there was an increasingly high rate of immobilization of equipment, which, of course, led to insufficient production levels and poor quality goods. This in turn has led to production losses and to the rapid deterioration of installations and a resultant diminution in their useful life span".

In 1979 during the opening session of the INPEC congress on maintenance in Hyderabad, India, the President of the Indian Republic stressed that his presence at the conference was indicative of the importance which he attached to maintenance. He went on to say that "the factory which costs least in terms of currency is the factory we already own... when we can make it work correctly".

In its 1984 report the Committee of Aid to Development (CAD) of the OECD drew attention to the problems of maintenance in the industrial projects in developing countries. After having recalled that the behaviour of the donor countries was equally at fault in the inadequate conception of these projects, the CAD stressed that "from an economic point of view, aid which prevents productive capital equipment from going to waste, not because it is obsolete or it has ceased to be viable but because of a lack of maintenance or spare parts, has the same effect as aid granted for the initial investment".

---

(1) - This contribution is based on a study carried out for the French Ministry of Foreign Relations, Cooperation and Development. Bureau des stratégies industrielles. Industrie.

1) LACK OF MAINTENANCE KNOW-HOW IN THE LDCs : A PROBLEM CALLING FOR A RAPID SOLUTION.

1.1 Many breakdowns... however the lack of maintenance know-how only explains some of the interruptions in production.

Interruptions in production in the factories of the L.D.C.s are a frequent occurrence. However we seldom have detailed information concerning the duration and the causes of these interruptions.

- In India, according to a survey carried out by the National Productivity Council in the late 70 s :

  . the effective running time was 65 % for fertilizer production plants, 75 % for thermal power stations ;

  . repair and maintenance work accounted for 20 to 25 % of production losses in the fertilizer production plants and 25 % in the power stations ;

  . the other factors causing production losses were related to problems of energy and raw material supplies.

- In a survey (1) on industry in Africa concerning 343 industrial projects, a French research body, the **Institut de l'Entreprise**, recorded 274 projects which were not running properly (80) including 74 which had been completely halted. When attempting to identify the causes of this situation, the authors of this survey adopted three main categories matching the major phases in the realization of the projects.

  . circumstantial causes relating to the programming of the projects : absence of serious economic reasons for launching the project in the first place, inaccurate evaluation of the market, lack of industrial integration ;

  . circumstantial causes relating to the realization of the installations : mistakes in the choice of technical processes, absence of funds for the local aspects of the project (civil engineering, assembly), insufficient training and technical assistance ;

  . circumstantial causes relating to the running of the plants: absence of industrial culture and traditions, maintenance.

---

(1) - North-South-Centre of the Institut de l'Entreprise. Pour un vrai partenariat industriel en Afrique - bilan et perspective de l'industrie africaine, Paris, May 1985.

In summing up the results of the survey the authors stress the fact that it is once the plant is actually running that most problems arise : "The problems of marketing and administrative regulations have damaging repercussions on all sectors. With the exception of textiles and brewing, which most often benefit from multiform assistance from western companies, all other sectors are badly hit by difficulties concerning the running of plants and maintenance. The problems of maintenance of installations result from the lack of industrial tradition".

In Africa we may estimate that maintenance problems account for 30 % of the losses of production capacity in production units.

1.2. The costs of the lack of maintenance know-how

During the symposium on maintenance in the L.D.C.s held in 1973 in Tokyo by UNIDO and the Japanese government, it was indicated that the **life span of capital equipment** in the LDCs was cut by 30 % because of a lack of maintenance capacities. It was also estimated that this diminution of the life span of capital equipment had resulted in a net annual loss of 5 to 7 billion dollars for the L.D.C.s as a whole.

In addition to the direct costs of faculty running of equipment in production units of the L.D.C.s, it is necessary also to take into account the indirect costs : unmet overhead costs, unincorporated variable costs, lost profit margins. If the frequency and duration of the interruptions are such as to cause supply shortages on the market, or if the quality of the products is known to be unsatisfactory, then the problems in the functioning of the equipment will lead to a loss of markets for the production unit. This sort of consequence should also be taken into account when calculating indirect costs. Another indirect cost which should also be evaluated, no longer concerning the production unit itself but rather at the national level, are the consequences on consumers and users and above all the attitudes of suspicion towards local production and preference for imported goods which can be encouraged by such a situation.

As far as international relations are concerned, the economic consequences of a lack of maintenance know-how in the LDCs can be equally important, especially concerning export-orientated industrial projects. Such projects, which were initially thought up in order to improve the balance of payments in these countries, have often had the opposite effect of increasing their foreign exchange deficit. This is because production units have frequent partial break-downs and the cost of importing spare parts and technical assistance is high. Such a self-induced increase in the debt of the L.D.C.s may well jeopardize the industrialized countries.

2) MULTIDIMENSIONAL MAINTENANCE

Maintenance, considered as "all the actions which make it possible to maintain or reestablish a good in a specified state, or enable it to provide a given service", has various aspects, depending on :

- the procedures used when engaging on maintenance work
- the objectives of the work
- the various levels at which such work may take place
- the functions which constitute maintenance work

These aspects may be more or less complex, or urgent, and it is necessary to take this into account when attempting to evaluate the level of maintenance ability reached by the various L.D.C.s.

2.1. Procedures used when engaging on maintenance work.

The following distinctions are to be made (1) :

- corrective maintenance carried out after a failure
- preventive maintenance carried out according to predetermined criteria, aimed at reducing the probability of failure of equipment, or deterioration of a service.
  - . systematic preventive maintenance, carried out according to a calendar based on time or the number of units used
  - . conditional preventive maintenance, subordinated to a predetermined event (self-diagnosis, data provided by a sensor, meausement of wear an tear, etc.).

2.2 Objectives of maintenance work.

In a given production unit the objectives set for maintenance work may be :

- to minimize stoppages in production (breakdown, tool change) i.e. to increase operating levels.

The quality of the maintenance work is then measured by the regularity of the "mean time between failures" (MTBF). In many LDCs, it is the mean time necessary for repair which often used as a reference

- for diminishing losses in machine performance, whether this be due to momentaneous failure or fall in rhythm.
- for decreasing the number of faulty parts.

---

(1)- AFNOR, Norme X 60-011, January 1981.

The Japan Management Association has integrated these three maintenance objectives in the concept of productive maintenance.

In the L.D.C.s the objective of maintenance work cannot be solely to decrease stoppage time. Even if this time is reduced, it is necessary to obtain a volume of production as close to the planned volume as possible, and to guarantee a minimal degree of quality.

2.3. Maintenance levels.

In its approach to industrial maintenance the AFNOR (1) proposes a five-tier distinction.

1st Level

Straight forward machine setting, envisaged by the constructor by means of accessible organs, without having to take the equipment apart or open it up ; or the replacement, without any safety problems, of accessible elements such as lights or certain fuses, etc...

This type of maintenance work can be carried out by the operator, on the spot, without specialized equipment, by referring to the instructions for use. The stock of replaceable parts is very small.

2nd Level

Repairs by standard replacement of elements intended for this purpose, and minor operations or preventive maintenance, such as lubrication or machine check.

This type of maintenance can be carried out by a technician of medium skill, on the spot, with the portable tools defined in the maintenance instructions, and with the assistance of these instructions.

3rd Level

Identification and diagnosis of break-downs, repairs by replacement or components of functional elements, minor mechanical repairs, and all common preventive maintenance work, such as general machine-setting or readjustment of measuring devices.

This type of maintenance can be carried out by a specialized technician, on the spot or in the repair shop, with the tools indicated in the maintenance instructions as well as measuring or adjustment/tuning devices, and, it necessary, testing benches and control equipment. Use will be made of all the documentation necessary to maintain the equipment in good order, as well as the parts supplied by the storage depot.

---

(1) - AFNOR, Norme X 60-001, January 1981.

4th Level

All important corrective or preventive maintenance work, with the exception of renovation and reconstruction work. This level also includes the adjustment of the measuring devices used in maintenance and, if required, the cheeking of standards of work by specialized bodies.

This type of maintenance can be carried out by a team including highly specialized engineers in a specialized workshop equipped with general tools (mechanical devices, cabling and cleaning equipment, etc.) and, if necessary, the required testing benches and devices for measuring work standards. All general and specific documentation may be used.

5th Level

Renovation, reconstruction, or important repairs carried out in a central workshop or by an outside unit.

In its X 50-501 standard recommendations the AFNOR suggests that the following operations should be distinguished:

- renovation, "complete inspection of all the components, complete dimensional checking or replacement of vital parts by original parts or the equivalent new parts"

- reconstruction, "overhauling as defined by the initial specifications which impose the replacement of vital parts by original parts or the equivalent new parts".

Reconstruction should be distinguished from "**modernization** i.e." the replacement of equipment, accessories, devices, or, when applicable, software, which by technically improving the original equipment make it more apt to perform the work for which it was designed. Theses operations can be carried out during both renovation and reconstruction. Nevertheless it should be noted that modernization represents a higher stage of complexity which may be considered as the 6th level of maintenance.

2.4. The functions which constitute maintenance work.

To be fully effective maintenance work should result from several functions which may be the object of various services.

a) the **methods function** which defines the methods, techniques, means and standards of maintenance.
The methods function should, in particular, be in charge of:
. building up operational technical documentation (technical brief according to the type of material, technical data sheet on each apparatus, break-down check-list...)

. forecasting and preparing maintenance operations

. examining production results and elaborating preventive maintenance methods

b) the **programming function** is responsible for sequencing comparisons between needs and availabe staff, tools, machines and spare parts

c) the **operation function** covers the operational maintenance staff (repair service) and is in charge of :

- supervision of installations

- carrying out maintenance work

d) the **logistics function** covers

- the storage depot for spare and replaceable parts which is in charge of supplying and managing stocks

- the repair shop.

2.5. Conclusion : maintenance is mainly to do with information

If we analyze the nature of the various activities involved in maintenance functions then we observe that only the activities of "executing maintenance work" (operation function) and of the repair shops consist in material operations : disassembling and reassembling parts or components, production of spare parts. All the other activities mainly involve the handling of information :

Collecting information :

- supervision of installations

- procuring technical documentation

Information processing :

- determining requirements in terms of spare-parts and supplying

- planning maintenance operations

- sequencing

- stock management

Memorization of information :

- elaboration of preventive maintenance methods

- organization of the technical documentation.

3) PARTICULARITIES OF INDUSTRIAL MAINTENANCE PROBLEMS IN THE L.D.C.s

3.1. The poor functioning of supply networks for spare parts

In the developing countries, the logistics necessary to ensure the effective distribution of spare parts are often lacking. Whatever the country in the Third World, the reaction is unanimous : the problem to be solved before any other is that of obtaining spare-parts. At the present time, the incredible diversity of component parts makes this problem all the more difficult ; and parts which are simple enough to be manufactured on the spot are increasingly rare.

The main difficulties which firms have to face in obtaining spare parts (1)

- determining the part, and technical documentation

A broken part must first of all be clearly indentified, without any possible confusion. This presupposes that the user has an identification system (this is seldom the case) which enables the maintenance team to designate the part rapidly and to find the means of access to the appropriate documents. This raises the problem of a correct codification system, which is easy to enter and stable over time, as well as the updating of the spare parts catalogue and the operating and maintenance manuals. "Whether it is because the documentation is incomplete (the cost of complete technical documentation for a plant may represent more than 10 % of the investment costs), or difficult to use (for example because it is in a foreign language, has been badly translated, has not been standardized, ect...), such deficiencies have damaging consequences on several levels. They cause a tremendous loss of time in identifying and repairing breakdowns ; they may also jeopardize safety within the plant and lead to spare parts being supplied or produced on the spot" (2).

- Finding a vendor

This may be a tricky operation when obsolete parts have to be found, or when the original supplier has gone bankrupt or been absorbed by another firm. It becomes all the more complicated in a developing country where means of communication are often interrupted or unstable.

---

(1) - For more detail, see C. NEYRET, Les pièces de rechange dans la maintenance des entreprises des pays en développement. Achats et entretien N. 342. June 1982, pp. 53-72.

(2) - P. de Groute and H. Schellers, Réflexions sur la maintenance d'installations industrielles dans un environnement non-industriel. Acier Arabe N. 68, 1979, pp. 51-85.

- Financial obstacles

Once the part and the vendor have been identified the purchasing enterprise must dispose of the necessary financial resources, and the country in question must also dispose of the necessary currency reserves. Examples of L.D.C.s which have had to limit or momentarily stop their imports of spare parts are unfortunately not uncommon, especially since these countries have begun to experience growing external debt problems.

- Customs and administrative barriers

In the purchasing enterprises country the import and payment procedures, which also apply to spare part purchases, come within the competence of three different administrations: the Ministries of Finance, Foreign Trade and Industry. It is sometimes difficult to harmonize these three types of regulation, which result from and reflect the fact that the government endeavours to control its foreign exchange transactions, to protect its infant industries and to obtain detailed statistical information on imports. Thus preliminary authorization mechanisms are established, import licences (quota systems) become necessary, and differential taxation according to the type of product is introduced.

3.2. Insufficient capacities of local maintenance services

In order to solve the numerous problems involved in buying spare parts, one solution could be to improve the operating capacity of local maintenance services, especially for simple mechanical parts, made of common metals (medium carbon steel, bronze) and which can be machined on the spot with a lathe, a milling machine or even a grinding machine (1).

In most cases, the possibilities of sub-contracting work to already existing local services are insufficient. This has led to the programming of repair shops which are too big for the factories concerned, and has involved heavy extra costs when the production units were being set up.

---

(1) - With the development of electric and electronic devices, hydraulics, and high performance mechanical components cast in special thermally processed steels (which are thus as complex as they are precise) this has become increasingly difficult. The use of small engines, built into the body of the machine and impossible to rewind, has become increasingly widespread.

3.3. The lack of industrial traditions in the labour force

The lack of training and above all the lack of industrial traditions (and therefore of experience) which characterize most developing countries have meant that the technical skills of the personnel are generally low, especially among foremen and skilled workers (craftsmen). This lack of industrial experience involves the equipment in being submitted to abnormal, or at least unforeseen operating conditions. Training is therefore absolutely necessary not only for the maintenance staff but also for production line workers. As a result of this situation in the labour force, it is necessary to adapt the equipment, and more safety devices should be introduced, especially as an antidote to misuse during operation.

3.4. Turn-key factories

During the sixties and seventies the L.D.C.s bought a great number of turn-key factories. Although it may be true that such contracts enabled these countries to acquire production units rapidly, this did not however solve the problems of acquiring technical know-how and knowledge, and more particularly of mastering maintenance skills. For a long time turn-key contracts created illusions about the transfer of technology ; technological know-how cannot be acquired solely through contractual procedures, but involves a high degree of commitment from the personnel in question. Moreover, as opposed to the hopes of the contractors in the L.D.C.s, the more global a purchase contract is the more difficult it is to control the purchasing operations. Thus turn-key contracts most often include the supply of a first batch of spare parts, but in many cases these parts turned out to be ill adapted to local requirements. It is impossible for the contractor in the L.D.C. to control such supplies and to ensure that they are adapted to his future requirements. As far as the prime contractor selling the factory is concerned, he is committed to selling it at an all-in price but always has to cope with unforeseen expenditure : he will naturally attempt to make up his losses on other items, and particularly on spare parts. Moreover, when it is a matter of constructing and industrial complex, it is impossible for the prime contractor alone to determine what spare parts will be needed, unless he undertakes a thorough and detailed study, which would then have to be counted in the cost of the contract (1). In a situation in which international competition is intense in the field of complete industrial units, contractors can only hope to win contracts by decreasing their profit margins and therefore reducing their services, especially with regard to maintenance which has no immediate impact at the time of the construction and start-up of the factory.

---

(1) - Batches of spare-parts provided in the framework of turn-key contracts may at the same time include identical parts which come under different codes, and exclude essential parts.

3.5. Capital equipment from different countries

Turnkey contracts at least have the advantage, as far as spare-parts are concerned, of supplying material which is built according to the same system of technical norms. The L.D.C.s, who are rightly trying to avoid new situations of dependence, have decided to diversify their purchases of turnkey factories. Such a practice however has the disadvantage of creating difficulties in the management of stocks of spare parts, and of increasing such stocks both at the level of the industrial complex and at the national level.

3.6. Conclusion : In a non-industrial environment there is a greater need for collecting and processing information

In the non-industrialized or only partly industrialized environments which predominate in the L.D.C.s everything seems to make the information-related activities necessary for maintenance work more complex. Many obstacles perturb the activities of collecting and memorizing information. Break-downs in the telecommunications systems, problems in or the absence of spare-part supply networks, insufficient local production capacity for spare-parts make it all the more necessary to programme maintenance operations rigorously and to plan the management of spare parts in advance. The diversification of capital equipment suppliers makes it more difficult to identify spare parts, organize the technical documentation and manage the stocks. Last of all, the lack of industrial traditions in the labour force increases the number of break-downs and makes it more complicated to diagnose the causes correctly.

4) MAINTENANCE TRAINING REQUIREMENTS IN THE L.D.C.s

4.1. Action to be undertaken with regard to three different categories of operators

Training requirements in the L.D.C.s are very great, particularly in the field of maintenance, and it will be impossible to meet all these needs in the short run. Priorities must be decided on concerning production units which have already been built and those which are programmed, and the education systems.

- At the level of **production units** already in use, local surveys show that maintenance training only lasted a few months -in the most favourable cases- for personnel who most often had no initial technical training. This has been aggravated by numerous departures of trained staff, or their promotion to management posts. The training which is given is either of a standard type and therefore poorly adapted to the needs of the trainees, or on-the-job training operations which run the risk of creating blanks of the theoretical or technical knowledge so acquired.

- As far as the **projects under study** are concerned, national contractors are increasingly aware of the necessity of providing for specific training in maintenance in the contracts. Nonetheless, many questions remain : what should be the form and the content of the training ? Should it be general or specific ? Who should be the trainees ? Should it be short-term or long-term ? Should there be specific and individualized contracts ? How should the training be evaluated ?

- Many countries are in the process of setting up or reinforcing their maintenance training systems, by :

  . creating specialized institutes (Algeria-India) or workshop-schools (Niger, Mali, Guinea) ;

  . setting up new courses in their educational systems, at school and post-school diploma levels. Thus the Ivory Coast recently created a two-year post school technical diploma in maintenance. Several other African countries (Mali, the Senegal, the Cameroons, Gabon) have plans to follow the same path in setting up higher education diplomas in maintenance ;

  . the development of maintenance activities within the framework of adult training (Morocco).

When such training schemes do exist contractors complain of the small number of personnel actually trained, and the insufficient level of the qualifications so acquired.

4.2. Two action priorities : organization and standardization

The technical training provided in such systems for the personnel of production units already in use or programmed should include two key aspects :

- the organization of maintenance

- the normalizing and standardizing of spare-parts.

Training for maintenance organization

In order to cope with the many difficulties of maintenance in a non-industrial environment many maintenance engineers in production units have discovered that there is an urgent need to develop training in management and sequencing of maintenance work. Thorough knowledge of the **methods function** is particularly important in order to deal with all the information necessary for maintenance operations in a plant, especially if it operates in a non-industrial environment.

Training in normalizing and standardizing spare-parts

The normalizing of identification of spare parts has become a widespread demand from plant managers, who have to cope with the problems of handling spare parts supplied by numerous constructors from various countries.

Another form of normalization which is often mentioned concerns technical documentation. In this respect the often heard-complaint is that such documentation is intended more for construction than maintenance.

The standardization of spare parts, which would make it possible to reduce their number, is also demanded by plant managers. This objective is also included in most national maintenance plans as a prerequisite for setting ut a local spare-parts industry.

4.3. Different needs from one country to another

The foregoing priorities must be given content in relation to the level of development and the particular requirements of each country :

- in India the need to ensure training in preventive maintenance is more explicit than in other countries ;

- in African countries training requirements concern above all corrective maintenance, on levels 1, 2 and 5, and the realization and programming function. On the other hand, India is more interested in preventive maintenance, the methods function and maintenance levels 4 and 5 (i.e. modernization operations).

Rehabilitation and modernization

It is at this (5th) level of maintenance, concerning the reconstruction and modernization of plants, that the differences between L.D.C.s are most marked.

In Africa the number of units of production being rehabilitated or reconstructed is impressive. Among the rehabilitation contracts carried out during 1984 by European engineering companies in Africa we could mention an oil-mill in the Congo, a cloth mill in Mozambique, a pineapple cannery in Guinea, an ammonia plant in Algeria, a textile plant in Chad and another in the Cameroons. Some of these plants have never actually functioned (design problems) or were destroyed at start-up or during the first few months because of a piloting error. The rehabilitation of these production units is usually carried out by foreign companies under turnkey-type contracts. Such contrcts sometimes include maintenance training, but in general once the plant has been reconstructed the local company has benefited little from new maintenance skills.

The modernization of old factories in India is carried out in a very different manner. Although engineering companies are not completely barred from such operations, they are more often undertaken by production firms having acquired modernization know-how on their own installation. This was the underlying principle in the case of two French firms in India, Lafarge Conseil Etude (LCE) and Neyrpid BMB respectively in the modernization and improvement of the energy efficiency of a cement works and in the adaptation of paper processing machinery to new raw materials.

Nevertheless, before signing a modernization contract with a foreign partner Indian Companies demand preliminary studies which are sometimes very costly. The Indian Companies' attitude to foreign partners has two major reasons :

- India considers itself to be well-equipped in capital goods industries and wants to limit the importation of machines. There may be exceptions -and these in fact are increasingly numerous- but they must be justified by the absence of a local supplier, or financed by foreign or international funds.

- Indian industrialists prefer to remain in charge of the modifications carried out on their production units. Although they appreciate foreign technology, they want to integrate it themselves, and they are capable of doing so. In India the scientific and technical "labour force" is estimated to represent 2.5 million people. There are 100 universities throughout the country, 6 000 colleges and many polytechnical institutes or industrial training centres, which taken together train 200 000 young people a year.

5) PROPOSALS FOR ACTION BY UNIDO IN THE FIELD OF MAINTENANCE TRAINING

5.1. Drafting of the "maintenance" part of standard specifications concerning purchases of capital equipment

Some of the maintenance problems of the L.D.C.s could be removed or more easily resolved if certain measures were taken when purchasing capital equipment. Maintenance specifications should be imposed by owners in the L.D.C.s in every order for an industrial installation or major equipment. The following points should be specified :

- the contents of the technical documentation, especially assembly plans, maintenance manuals, lists of spare parts, the form of presentation of the documentation and its codification system ;

- the choice of spare parts, the quantity of the first batch of spare parts, average consumption, storing conditions and above all the modalities guaranteeing permanent and unproblematic supplies. These specifications should also indicate the type of parts which could be manufactured on the spot and under what conditions (realization plans should be supplied by the capital equipment constructors). The amount and type of training that the supplier should provide for both production and maintenance personnel should also be specified.

Since this type of training includes standardization activities the standardization bodies in the countries concerned should take responsability for it, with the support of UNIDO.

With regard to maintenance specifications and the constraints to be imposed on suppliers, it is possible to go forward rapidly. We could take the recent case of the underground in Caracas, as an notable example. The local owner, assisted by the American consultancy firm, Bechtel, imposed very severe specifications, concerning both the availability of sub-systems and the costs of corrective maintenance and of slocks of spare-parts. It is more than likely that this type of specification, which is common in armaments and the space industry will little by little be extended to other industries, including those of the L.D.C.s.

PROPOSAL N. 1

Conception by UNIDO of programmes for training courses on the drafting of the maintenance part of specifications concerning purchases of capital equipment. The value of developing such specifications could be illustrated by many examples in various countries and industries. An exchange of experiences between various countries for similar

enterprises belonging to the same industries should be encouraged when setting up these training schemes. The experience acquired in this field by standardization bodies in the industrialized countries (the AFNOR, for example) should be used to the utmost.

5.2. Assistance in codifying spare-parts

When ordering spare-parts it is necessary to identify them precisely. The operations involved in codifying parts should respect precise characteristics to enable the vendor to supply the exact part requested by the buyer.

PROPOSAL N. 2

Experimentally in some L.D.C.s, technical experts, with adequate training acquired in a specialized course, should be employed to train people in each firm in the use of existing technical documentation, and in codifying spare-parts. These technical missions would also be aimed at completing the technical documentation and above all organizing it correctly.

5.3. Information processing as an aid to maintenance management

A particular aspect which is stressed in all case studies concerns the difficulties which firms in L.D.C.s have in properly organizing the management of maintenance work :

- sequencing of maintenance operations
- management of work sequences
- organization of technical documentation
- management of stocks of spare parts
- preparation of maintenance manuals for each machine
- cost analysis.

The management of maintenance work calls for the control over and processing of a great amount of data. This is a field in which data-processing techniques can be usefully employed to solve problems more rapidly and at a lower cost, especially in countries which lack qualified technicians qith experience of industrial procedures. Some companies have developed progiciels for the management of maintenance work.

PROPOSAL N. 3

The management of maintenance work should be adopted by UNIDO as a key area for the application of new technologies to development. An inventory of the instruments available and of applications should be undertaken rapidly.

UNIDO should also encourage the constitution of data banks on the reliability of industrial components. Such data banks would be extremely useful for the firms in the L.D.C.s, who could then build up stocks of spare parts according to their needs.

UNIDO should also undertake a study on the possibilities of using computer aided maintenance, expert systems and tele-assistance in order to increase the "maintainability" of equipment in the L.D.C.s.

5.4. New methods in maintenance training to be encouraged

It would seem that the maintenance training provided in the framework of industrial projects, in courses organized by vocational training centres or in specialized courses within the national education systems, is seldom satisfactory.

The specific characteristics of maintenance activities no doubt require new training methods, especially when the trainees have little theoretical knowledge and come from a non-industrial environment. There has been some thinking and experimentation in this field of maintenance training :

- The BTE (Bureau des Temps Elémentaires) and the AFICE Rhône-Alpes (France) have piloted a study group on maintenance training. According to the members of this groupe, more than half of French companies believe, rightly or wrongly, that maintenance training is at present ill adapted. To be effective, maintenance training should be based not on design technology but on behaviour technology. There would seem to be a "maintenance profile" which is common to all firms, and which makes it possible to envisage modular training from a commonly shared base.

- Many training schemes have been set up in the L.D.C.s : courses integrated in the school system, specialized training centres, centres which combine training and the provision of maintenance services. In certain training experiments formerly acquired know-how was taken into account and valorized, whereas in others this was neglected in order to ensure training on a "solid basis".

For the production units in the L.D.C.s to run without too many failures, for production levels to become economically viable, for the manufacturing of good quality products, the workers in charge of maintenance and repair in these plants must be able to move rapidly from precise knowledge of the broken part, to knowledge about the machine and the plant as a whole. They will have to go beyond mere repair work and on to maintenance. This is all the more necessary for factories in the L.D.C.s designed on the same model as those in the industrialized countries, and with the some equipment, they have to operate in a non-industrial environment.

PROPOSAL N. 4

In association with the I.L.O. and other international bodies, UNIDO should argue in favour of an evaluation study on maintenance training methods in the L.D.C.s with a view to proposing new training programmes which will better match the needs of these countries.